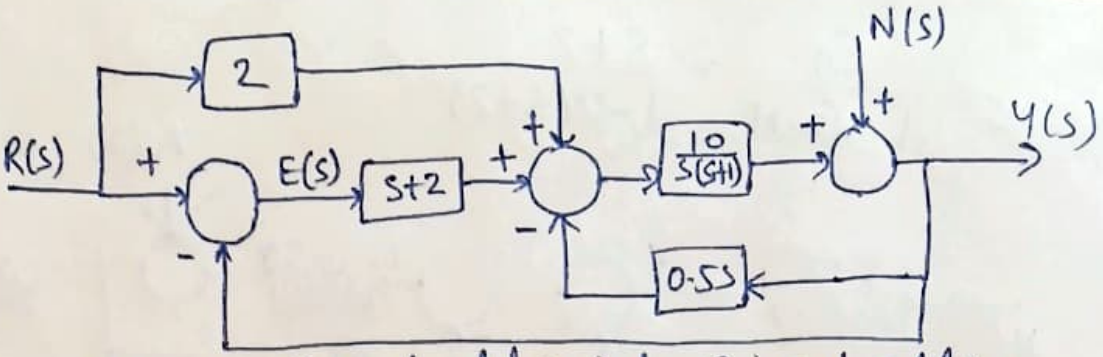
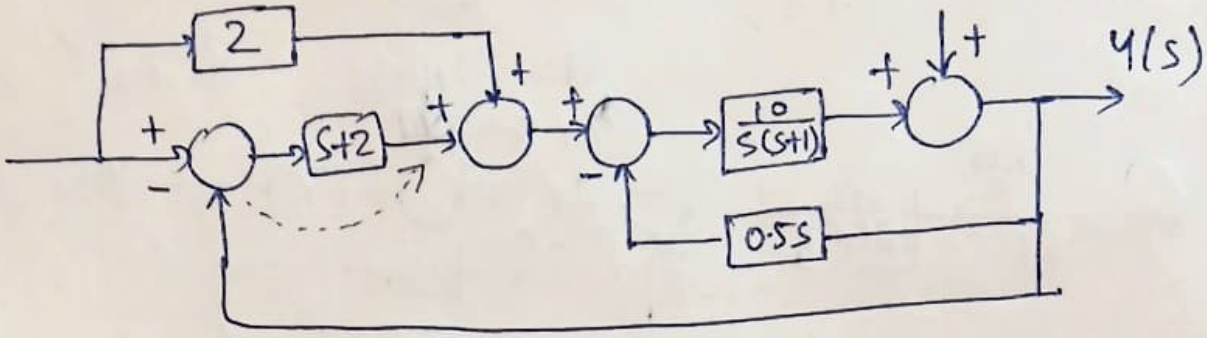
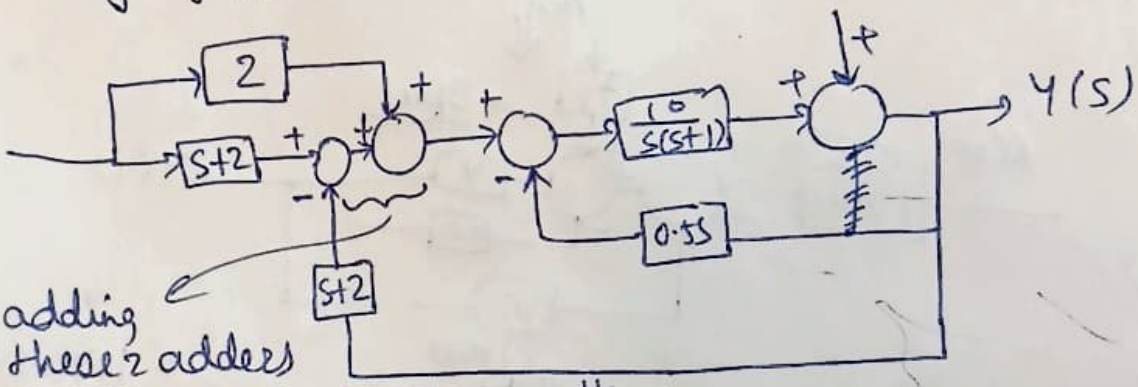
1.

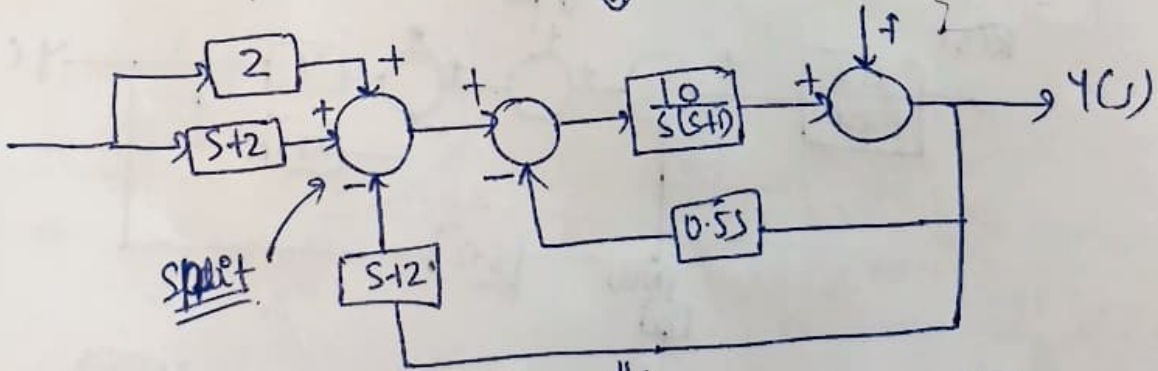


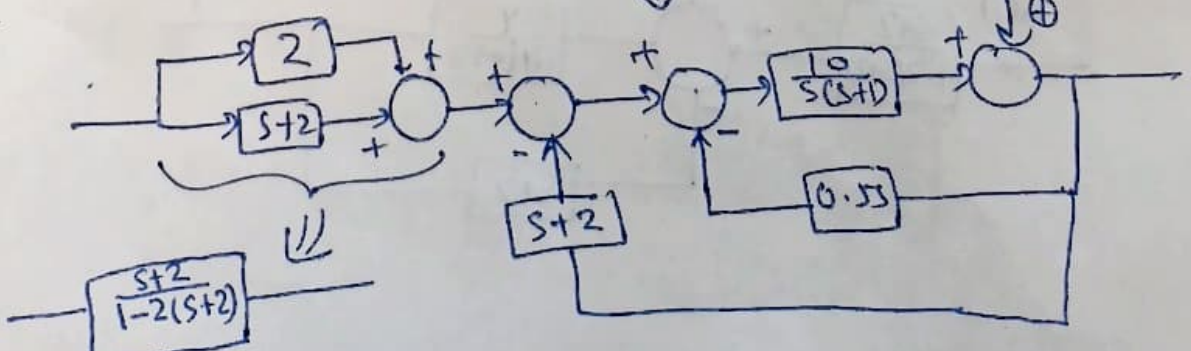
splitting the 3 input adder into 2 input adders



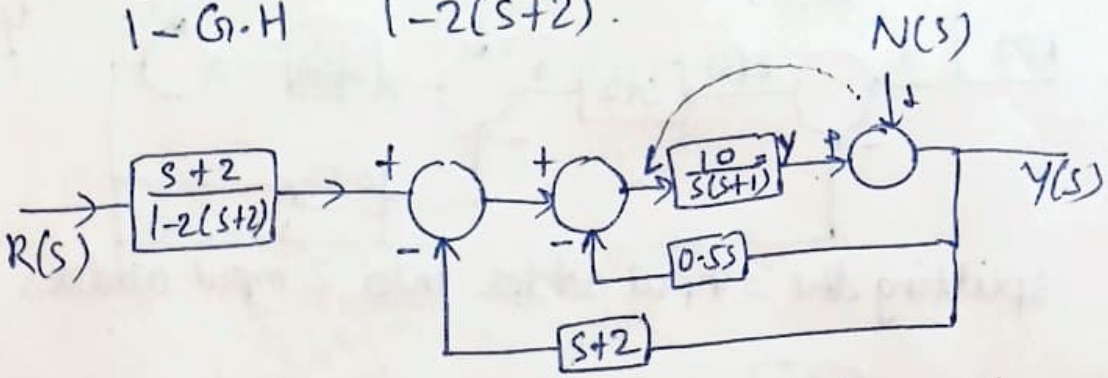
shifting adder



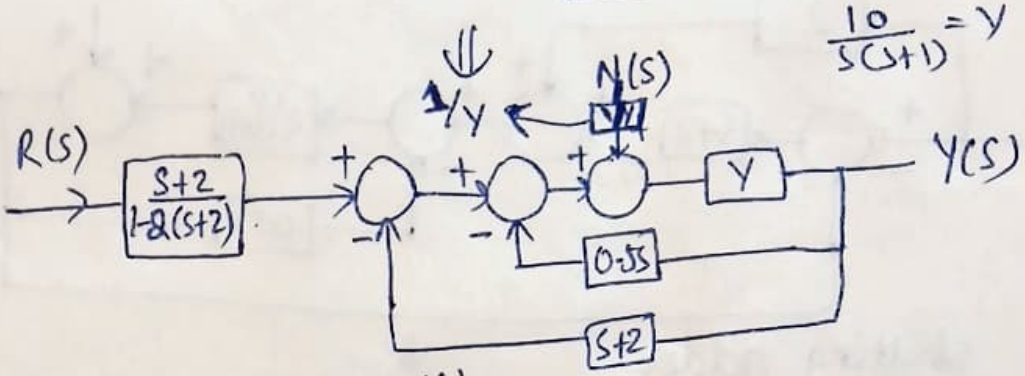


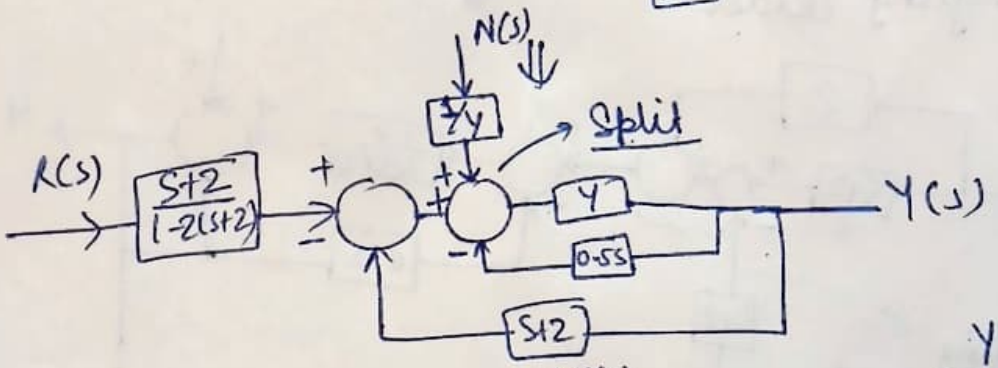


$$\frac{G_1}{1 - G_1 \cdot H} = \frac{S+2}{1-2(S+2)}.$$

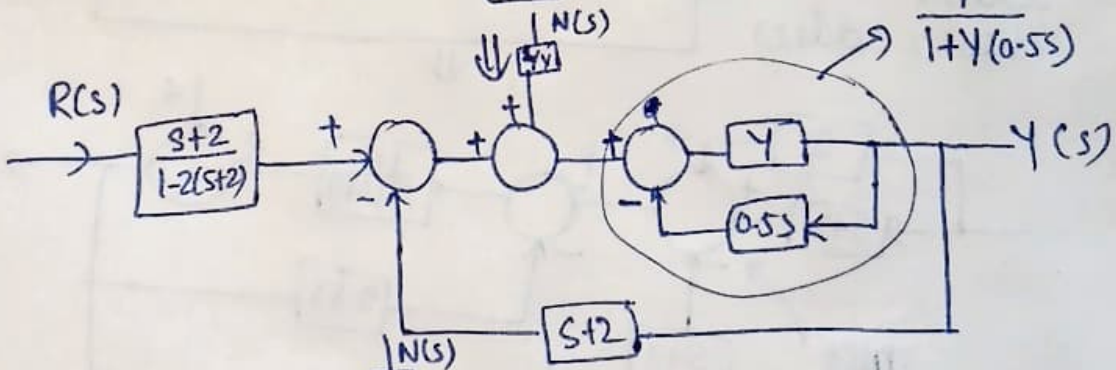


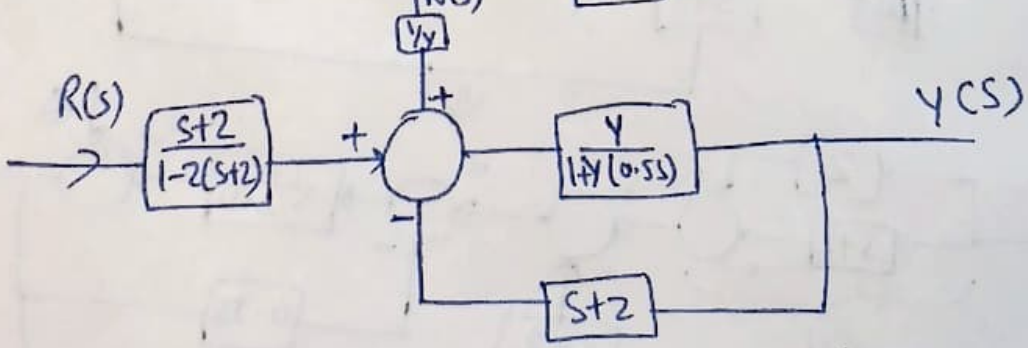
$\frac{10}{S(S+1)} = Y$

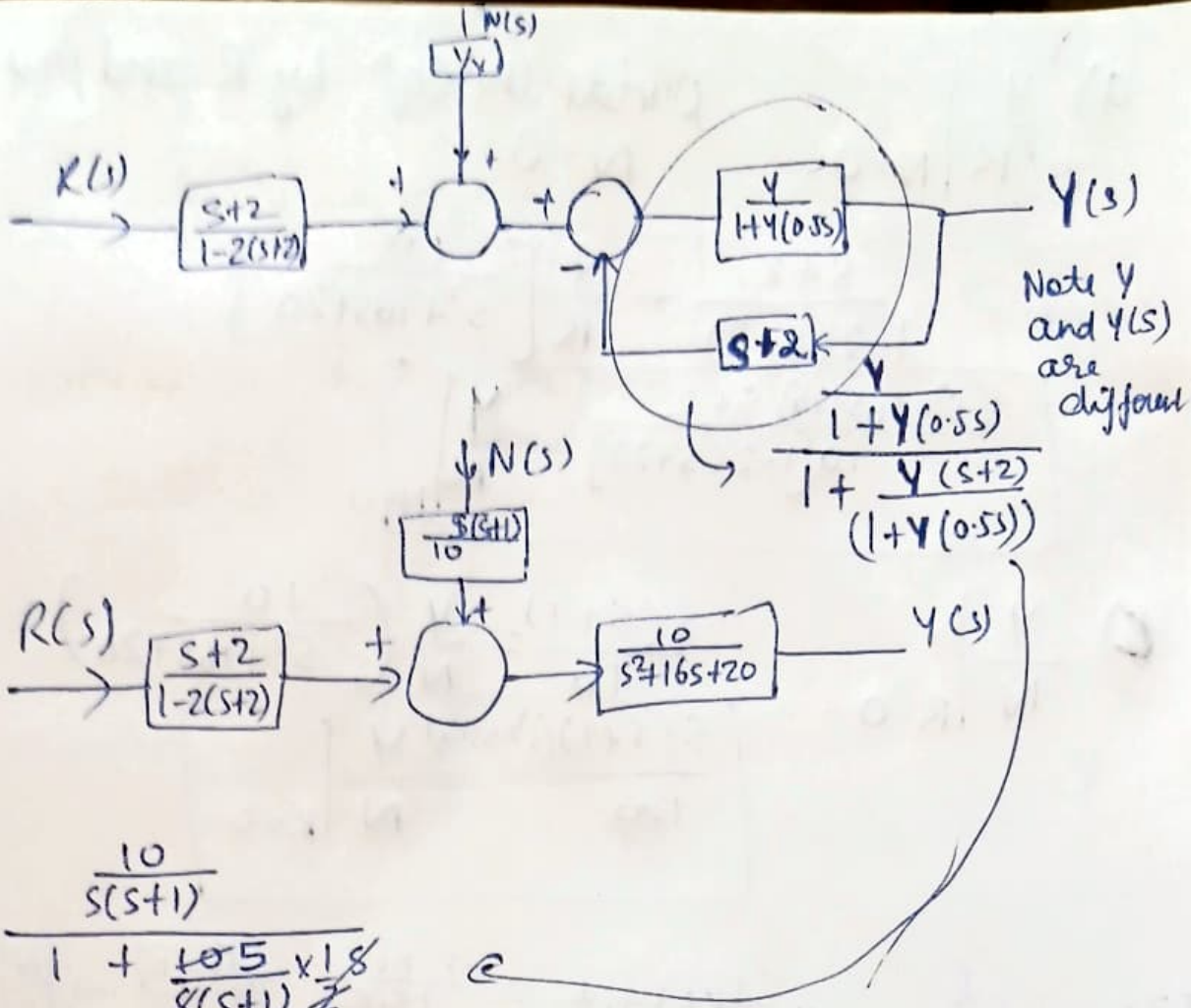




$\frac{Y}{1+Y(0.55)}$







$$\frac{\frac{10}{S(S+1)}}{1+\frac{10}{S(S+1)}\times\frac{1}{2}}$$

$$1+\frac{\frac{10}{S(S+1)}(S+2)}{1+\frac{10}{S(S+1)}\times\frac{1}{2}}$$

$$= \frac{\frac{10}{S(S+1)}}{\frac{S+6}{(S+1)}} \Big/ \left(1+\frac{\frac{10(S+2)}{S(S+1)}}{\frac{S+6}{(S+1)}}\right) = \frac{\frac{10}{S(S+6)}}{\frac{S^2+6S+10S+20}{S(S+6)}}$$

$$= \frac{10}{S(S+6)} \Big/ \frac{S^2+16S+20}{S(S+6)} = \frac{10}{S^2+16S+20}$$

So Eqⁿ is

$$R\left[\frac{S+2}{1-2(S+2)}\right] + N\left[\frac{S(S+1)}{10}\right] = Y\left[\frac{10}{S^2+16S+20}\right]$$

a) $\left.\frac{Y}{R}\right|_{N=0}$ Divide the Eq^ by R and put $N=0$.

$$\frac{\frac{S+2}{1-2(S+2)}}{} = \frac{Y}{R}\left[\frac{10}{S^2+16S+20}\right]$$

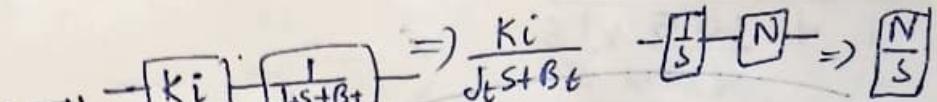
$$\frac{[S^2+16S+120]\,S+2}{10[1-2(S+2)]} = \left.\frac{Y}{R}\right|_{N=0}$$

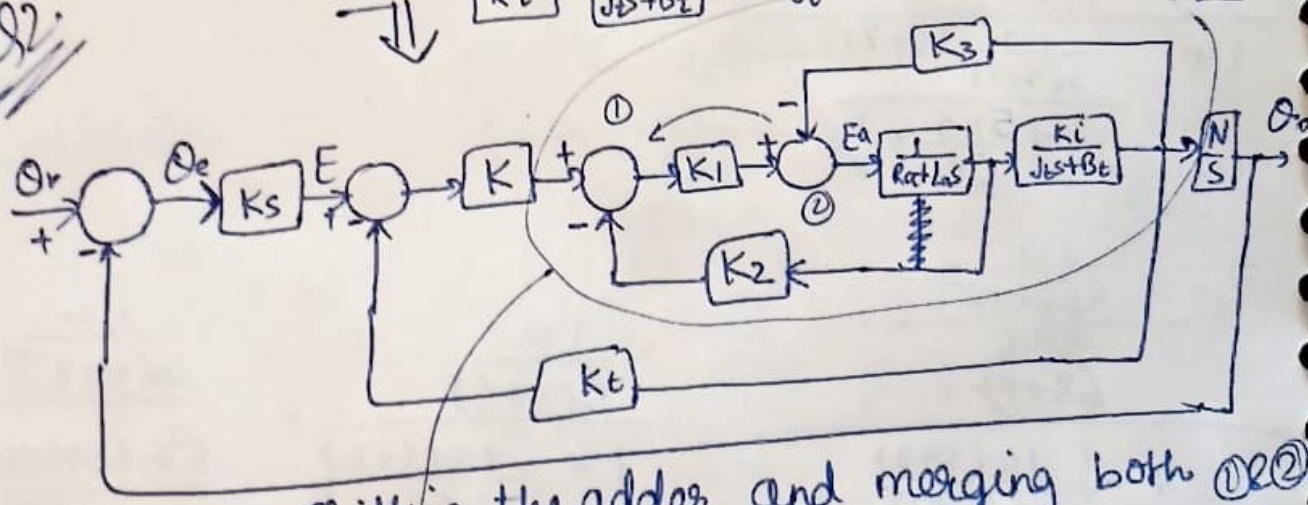
b) $\left.\frac{Y}{N}\right|_{R=0}$.

$$\frac{S(S+1)}{10} = \frac{Y}{N}\left(\frac{10}{S^2+16S+20}\right)$$

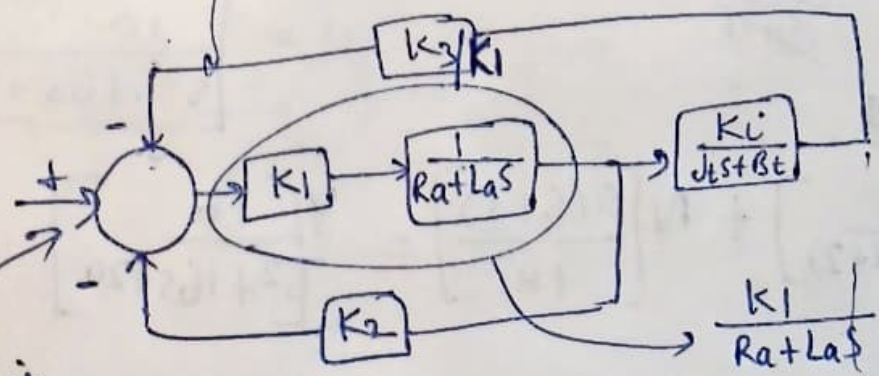
$$\frac{S(S+1)(S^2+16S+20)}{100} = \left.\frac{Y}{N}\right|_{R=0}$$

Q2.

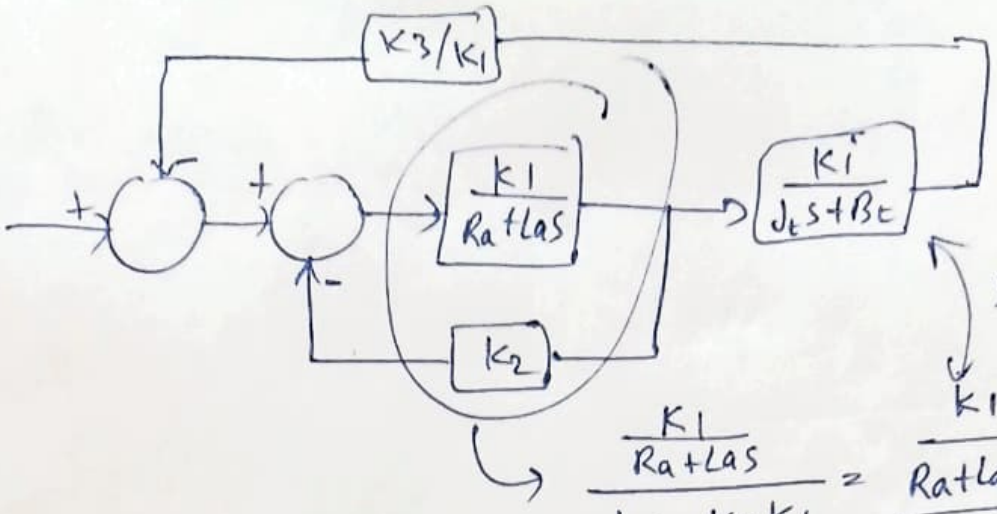




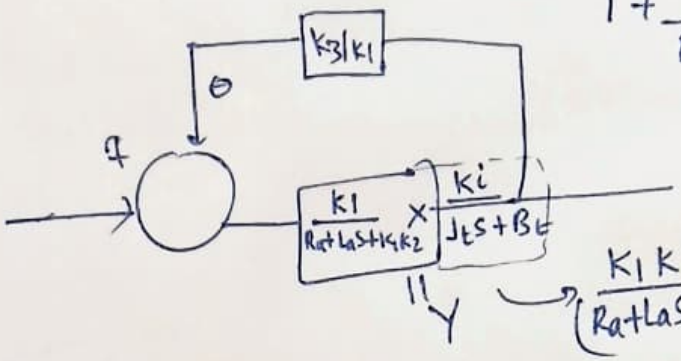
Shifting the adder and merging both ①②



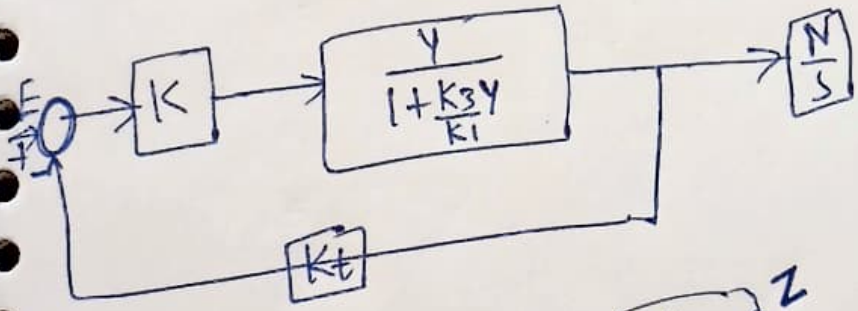
Split this

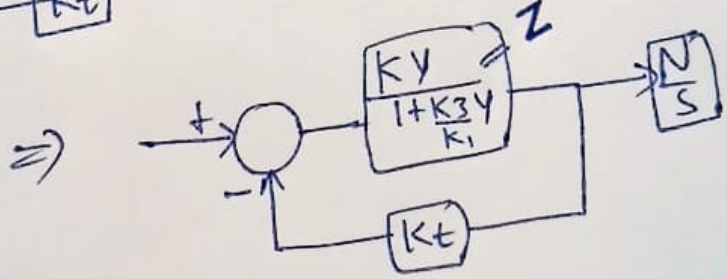


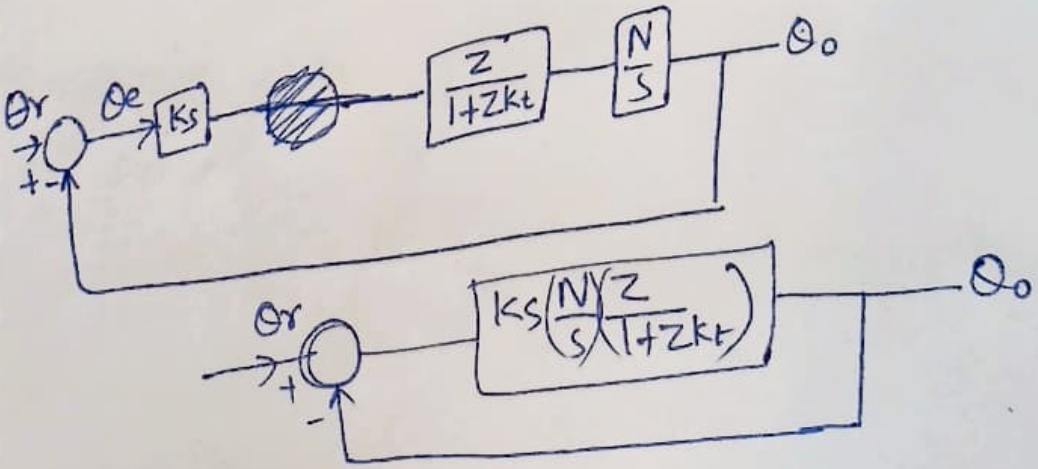
$$\frac{\frac{K_1}{Ra+LaS}}{1+\frac{K_2K_1}{Ra+LaS}} = \frac{K_1}{Ra+LaS+K_1K_2}$$

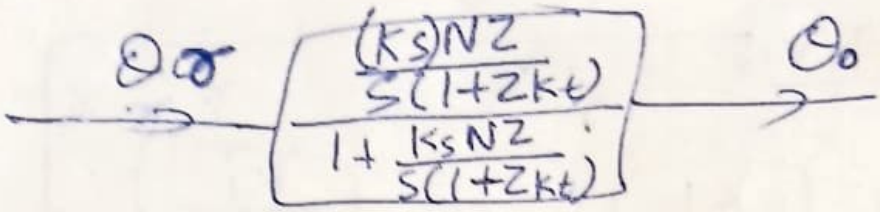


$$\frac{K_1 K_i}{(Ra+LaS+K_1K_2)(J_tS+B_t)} = Y$$









$$\frac{\theta_o}{\theta_r} = \frac{K_s N Z}{S(1+ZK_t)+K_s N Z}$$

where $Z = \dfrac{KY}{1+\frac{K_3}{K_1}Y}$

$$Y = \frac{K_1 K_i}{(R_a + L_a S + K_1 K_2)(J_t S + B_t)}$$